

# Sexual Selection

# Why sexual reproduction?

- why not many sexes?
- why not asexual reproduction?
- Hermaphrodite?

Benefits and costs of sexual reproduction?

# Asexual reproduction

Parthenogenesis: growth and development of embryos occur without fertilization.

-invertebrates, frogs, sharks, lizards, birds



# Red Queen hypothesis

*“Well, in our country,” said Alice, “you’d generally get to somewhere else – if you ran very fast for a long time as we have been doing.”*

*“A slow sort of country!” said the Queen.*

*“Now, here, you see, it takes all the running you can do to keep in the same place. If you want to get to somewhere else, you must run at least twice as fast as that!”*



Alice in Wonderland

# Red Queen hypothesis

Evolutionary arm race between  
**hosts** and **parasites**

Sexual reproduction

Increase genetic variation



Increase chance to capture parasites



Evolve better parasite-defense system



Parasites evolve better offense system



Sexual reproduction evolve better defense

# Nematode and its parasite

Grew nematodes without parasites

→ 20% sexual reproduction

Grew nematodes with Co-evolved parasites

→ 80-90 % sexual reproduction

Grew nematodes with non-evolved parasites

→ 20 % sexual reproduction

Sex helped populations adapt to their  
coevolving parasites

# Nematode and its parasites

Grew **mutant** nematodes w/ obligate **a**sexual  
→ Went extinct (exposed to parasites)

Grew **mutant** nematodes with w/ obligate sexual  
→ Population remains stable (exposed to parasites)

Sex helped populations adapt to their  
coevolving parasites

# Sexual Selection

Behavioral (morphological) traits that  
can be explained  
by intra-specific competition for  
reproduction

Darwin (1871): “ a struggle between the  
individuals of one sex, generally the males,  
for the possession of the other sex”.



# Sexual Selection: 2 forms

1. Intersexual selection  
(or mate choice)
2. Intrasexual selection  
(male-male competition)

# Male-male competition

## 1. Red deers compete for females



# Male-male competition

## 2. Elephant seals defend territory and dominance





# Mate choice

## 1. Peacock's tail feathers and display



# Sexual selection by mate choice

## 2. Song repertoire



Great reed warbler

Female warblers choose a territorial male who has a larger repertoire size.

# Sexual selection by mate choice

## 2. Dancing courtship in birds of paradise





# Sexual selection by mate choice

## 1. Male birds of paradise's plumage and display



# Mate choice

Why females tend to choose males?

Why males tend to have bright plumage, big song repertoire, bigger size?



# Why females choose, and males fight?

## 1. Gamete size:

Female: fewer, larger gametes (eggs), eggs are costly, valuable.

Male: more, smaller gametes (sperms) sperms are cheap to produce.

## 2. Investment on eggs and parental care

- fishes- external/ internal fertilization
- birds- lay eggs
- mammals- female nurture

# Evolutionary models of mate choice why females choose?

- 1. Direct benefit hypothesis
- 2. Good gene hypothesis
- 3. Runaway hypothesis
- 4. Sensory exploitation hypothesis

# Evolutionary models of mate choice what female choose?

- 1. Direct benefit hypothesis

choose mates provide them  
with resources: food, territory  
(home), assistance in  
parental care....

# 1. Direct benefit hypothesis



Female scorpionflies choose males that bring large prey items—food

1. Males with no food → rejected!
2. Males with food:  
females control the copulation time based on the size of prey!  
(why copulation time matters?)
3. What benefit females have by doing so?
4. Evolution of male's strategy?

# Evolutionary models of mate choice why females choose?

- 1. Direct benefit hypothesis
- 2. Good gene hypothesis
- 3. Runaway hypothesis
- 4. Sensory exploitation hypothesis

## 2. Good gene hypothesis

- Females are favored to choose mates that possess “good gene” – indirect benefit
- Good genes coded for favorable traits : plumage, song repertoire, capability to defend territory
- These traits are honest indicators of male quality – costly to produce.

# Handicapped trait signals “good gene”



Peacock's tail is  
handicapped, costly

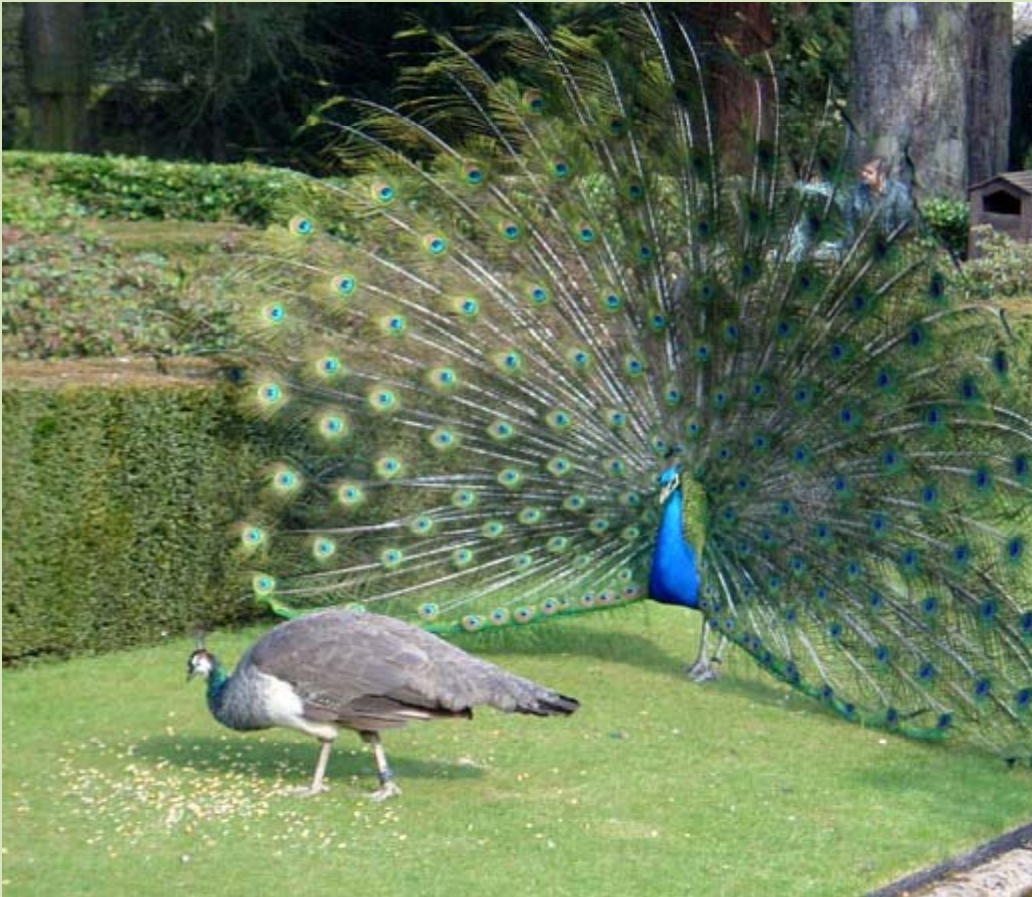
But the tail signals the strength  
and quality of males  
(I am handicapped, but I do well)

Choose this male will  
increase a female's  
reproductive success

Her offspring will  
carry the good genes



# Honest trait represents “good gene”



Peacock's tail is a honest signal of the male's genetic quality

Choose this male will increase a female's reproductive success

Her offspring will carry the good genes

The costlier the trait, the more difficult it is to fake



# Parasite-resistant is an honest trait



Plumage is a honest signal of the male's genetic quality ?

Bright, shiny plumage



Less parasites



Good Immune system



Healthy



Good gene

I love you!



Is it an honest indicator?

# Good gene hypothesis and tail **symmetry** in barn swallows



**Why symmetry is an honest signal of a male's health?**

Assume: mating with symmetry males → symmetry young



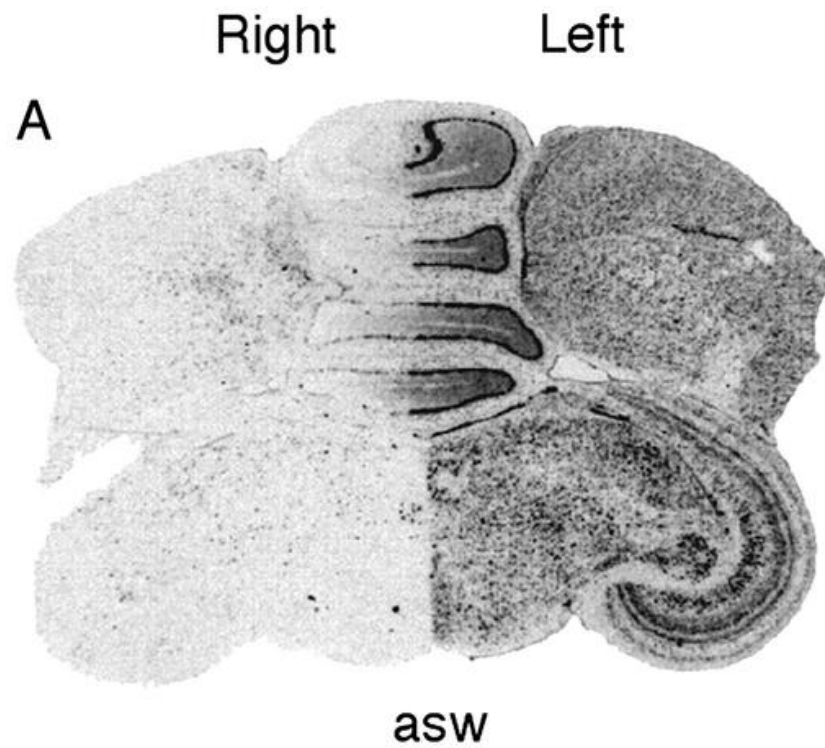
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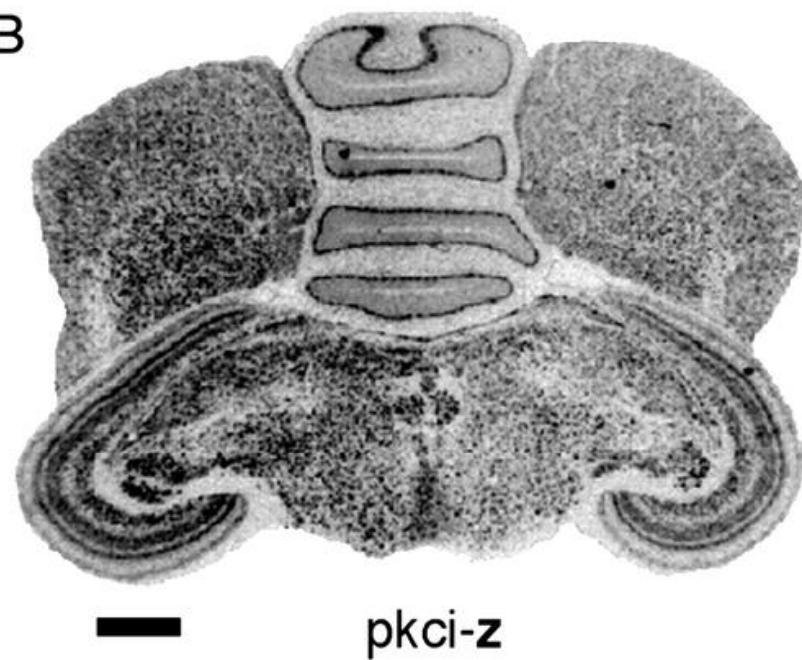
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# Good gene hypothesis and facial symmetry



**FACIAL SYMMETRY**

you're doing it wrong...

[motifake.com](http://motifake.com)



Symmetry as a honest signal of mate's health?

# Evolutionary models of mate choice why females choose?

- 1. Direct benefit hypothesis
- 2. Good gene hypothesis
- 3. Runaway hypothesis
- 4. Sensory exploitation hypothesis





widowbird

# Runaway hypothesis



widowbird

Need to have 2 sets of genes

One gene is coded for female preference of longer tail.



The other gene is coded for developing male's longer tail.



Females choose longer and longer tails;  
Males evolve longer and longer tails.



Runaway process

**\* Females gain no direct or indirect benefit by choosing a male.**



# Evolutionary models of mate choice why females choose?

- 1. Direct benefit hypothesis
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# Sensory bias model

1. Females bluebirds prefer feeding red berries; red berry increase survival/reproduction.
2. Females evolved sensory bias toward red color.
3. Male bluebirds who have red colored will be chosen and their red-colored genes pass on.
4. Eventually, all the males bluebirds evolve red plumage.

Males offer no direct or indirect benefit to females



# Sensory bias model

- Hearing habituation of the same stimulus

Female choose



“AAA AAA AAA AAA AAA”

Male Grackle #1



“AAA ABB AAA ABB AAA”

Male Grackle #2



Sensory bias model –  
Female zebra finches choose males  
that have red plastic band



Innate color preference

Design an experiment to test  
Runaway vs. good gene hypothesis??



Runaway model or Sensory bias model ?





Runaway model or/and sensory bias model?



# Good gene hypothesis and MHC gene

## MHC-dependent mate preferences in humans

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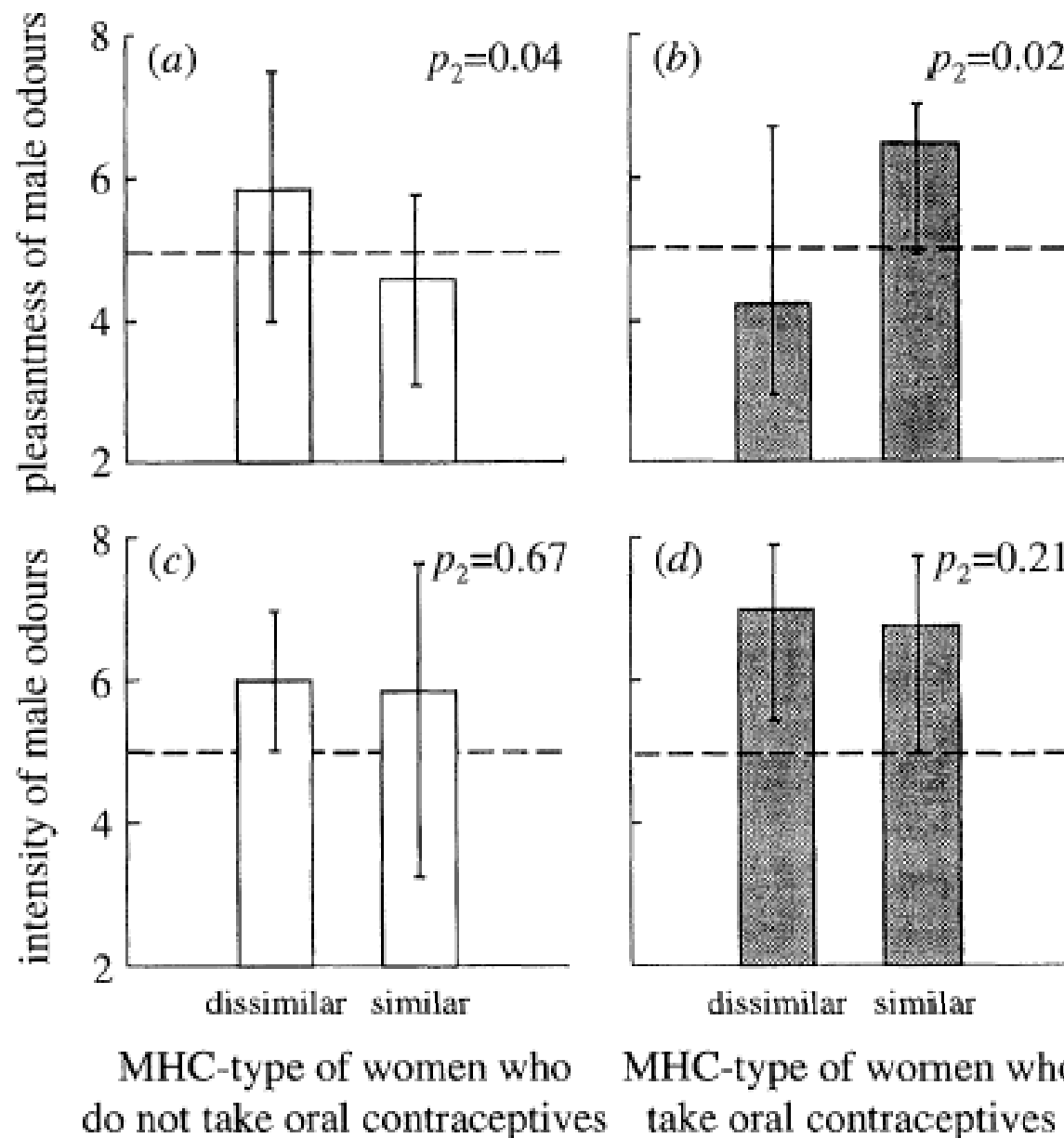
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### SUMMARY

One substantial benefit of sexual reproduction could be that it allows animals (including humans) to react rapidly to a continuously changing environmental selection pressure such as coevolving parasites. This counteraction would be most efficient if the females were able to provide their progeny with certain allele combinations for loci which may be crucial in the parasite-host arms race, for example the MHC (major histocompatibility complex). Here we show that the MHC influences both body odours and body odour preferences in humans, and that the women's preferences depend on their hormonal status. Female and male students were typed for their HLA-A, -B and -DR. Each male student wore a T-shirt for two consecutive nights. The next day, each female student was asked to rate the odours of six T-shirts. They scored male body odours as more pleasant when they differed from the men in their MHC than when they were more similar. This difference in odour assessment was reversed when the women rating the odours were taking oral contraceptives. Furthermore, the odours of MHC-dissimilar men remind the test women more often of their own actual or former mates than do the odours of MHC-similar men. This suggests that the MHC or linked genes influence human mate choice today.



# Good gene hypothesis and MHC gene



# Perfume to manipulate sensory bias?



## 2. Male bowerbirds build bowers (video)



What is the purpose of building bower?

Building bower is functionally equivalent to  
grow bright plumage or produce song.

What female choice model?





# Sexual selection by mate choice

## 1. Male satin bowerbirds build bowers





# The origin of sexually selected traits



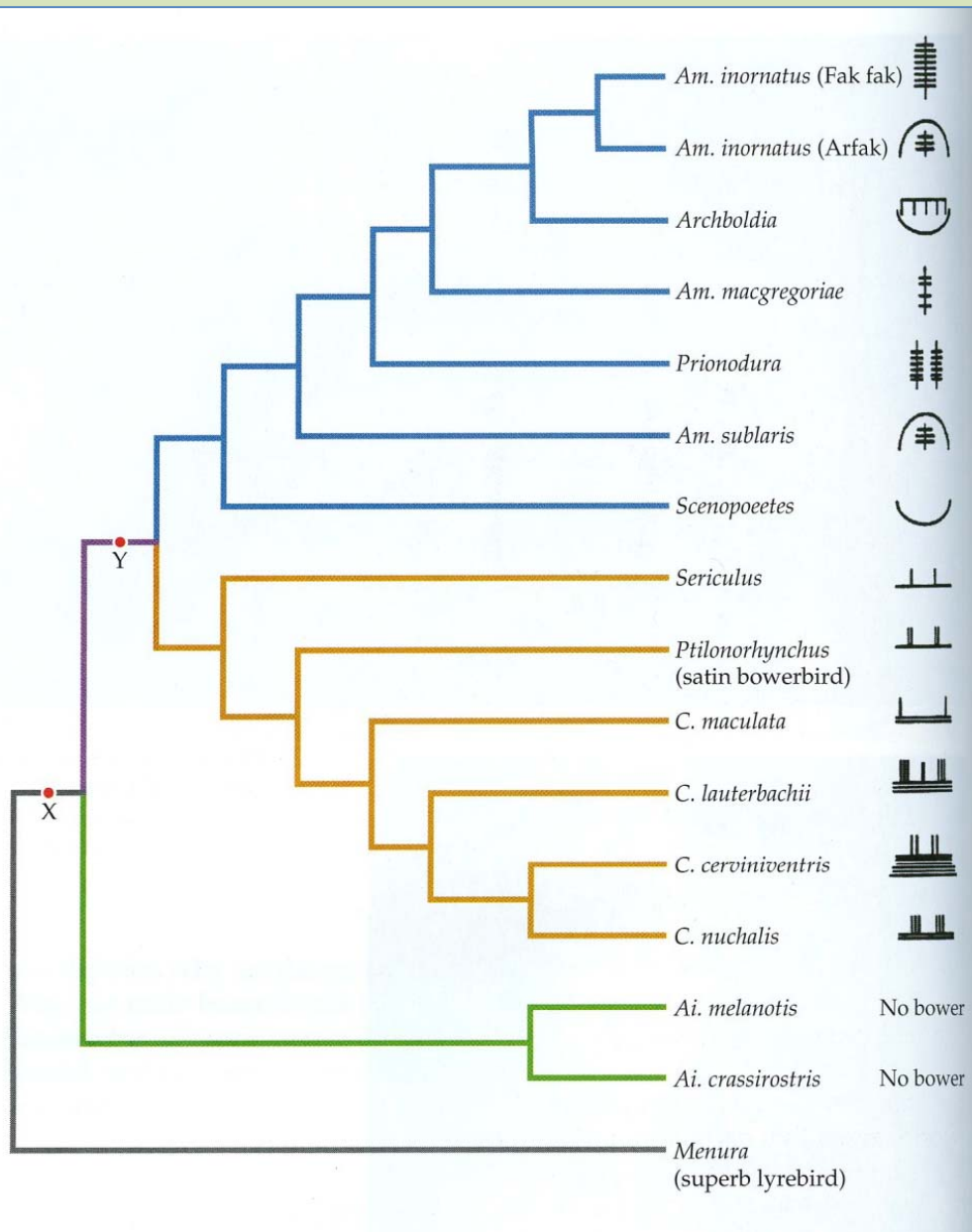
How does bower-building originate?

# The origin of bower-building behavior

## Phylogeny tree of bowerbird family

(using mitochondria DNA)

Study phylogeny can  
help us better  
understand how complex  
behavior has originated  
or evolved.





# Female sensory bias?

Male satin bowerbirds decorate bower using blue objects, sensory bias of females?





# Quiz: What female choice model?

## 1. Male birds of paradise's plumage and display



# Quiz: What female choice models?

## 2. Song repertoire



Great reed warbler

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# Strategies for male-male competition

Elephant seals: males compete for female harem



1. Dominant males
2. Subordinate males
3. Female interference

**Cost and benefits to be a dominant male ?**

# Male-male competition

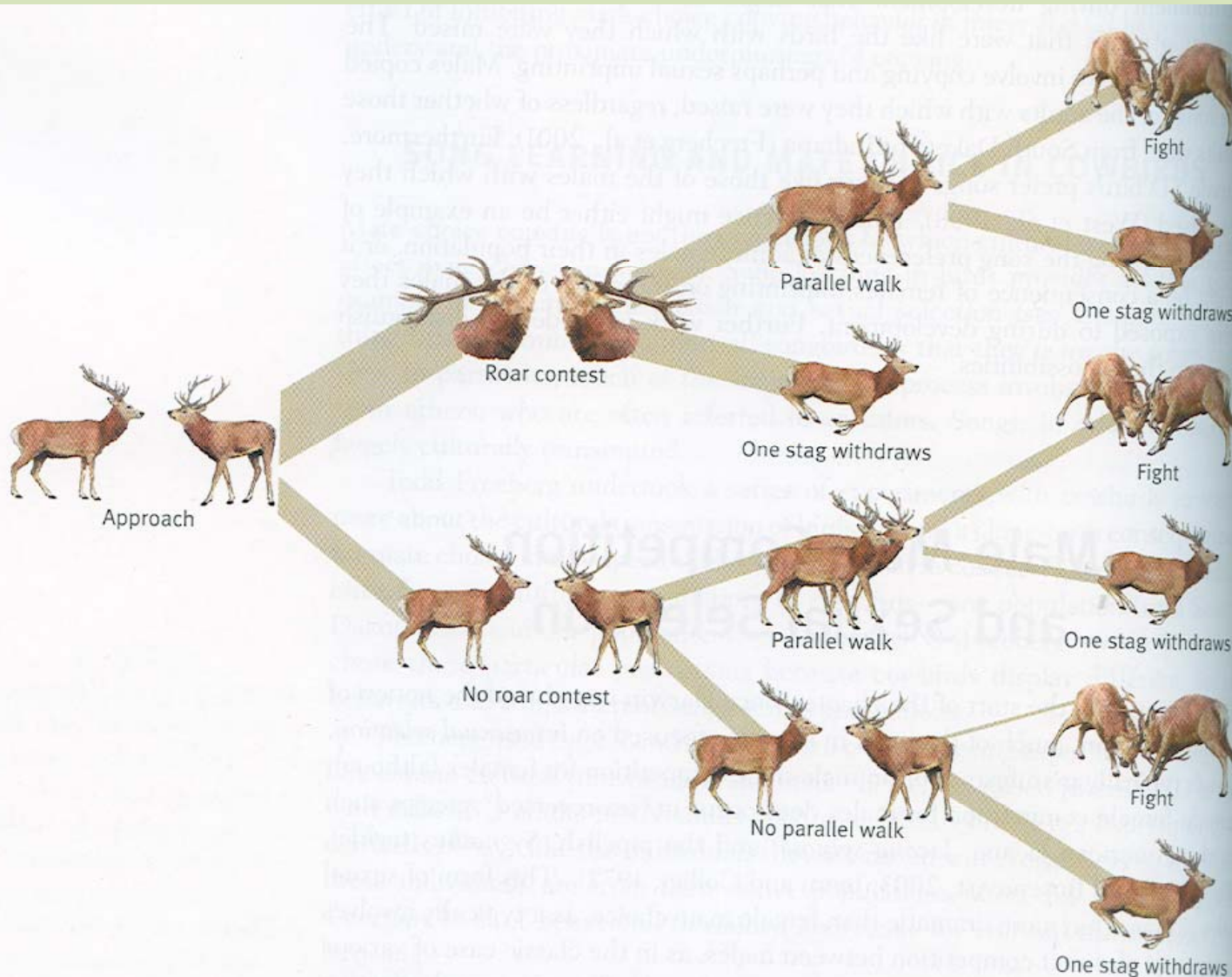
1. Male red-deers compete for females, but fighting has a big cost... so it is the last strategy to use..



1. Evaluate antler  
\* Honest indicator!
2. Roaring contest  
(honest signal?)
3. Fight

# Male-male competition

## 1. Male red deer's different strategies for competition



Fight or not?



# Strategies for male-male competition

\* Bluegill sunfish





# Strategies for male-male competition



Three male morphs:

1. Parental male (aggressive, bigger)
2. Sneaker male : “hit and run” strategy
3. Satellite male: looks like females



# Strategies for male-male competition

\* Bluegill sunfish



	Sperm quantity	Sperm quality	Sperm life
Parental male	fewer	higher	longer
Sneaker male	more	lower	shorter

# Male–male competition

## Male's alternative mating strategies

1. Develop friendship with the female (potential mate)
2. Develop friendship with other subordinates
3. Sneaker (when dominant males are not around)
4. Satellite behavior (female-mimicking)
5. Force-copulation



Most fish species have separate sexes,  
but many species individuals  
are capable of changing sex.



Coral reef fishes



Why should natural selection favor sex change? Under what circumstances might we expect sex change to be adaptive?

Size-advantage model:

an individual that functioned as a female when small and as a male after attaining a large size would have more offspring over its lifetime than one that remained either male or female.

Males: compete females, guard territory and eggs;  
→ bigger, stronger males have more reproductive success

A photograph of two clownfish swimming in a sea anemone. The anemone has many long, yellowish, tube-like tentacles. The clownfish are orange with white stripes and black outlines. The background is a clear blue ocean.

Design an experiment to test  
size-advantage model?

Remove the big-size male →  
smaller female change its sex to male

# How do humans choose their mate?

1. Wealth, power (direct benefit)
2. Health (good gene)
3. Odour (good gene)
4. Symmetry (good gene)
5. Look similar to parents (sexual imprinting)
6. Super-stimulus (sensory bias)
7. No reason (runaway or ?)
8. Love at first sight (many possibilities)
9. Cultural, religious, intellectual similarity
10. Combination of above.